

## CLAIMS

What is claimed is:

1. A redundant clock module comprising:  
at least two oscillators, a primary oscillator providing an output to the module and at least one secondary redundant oscillator to take over for the primary oscillator in case of a failure or out of tolerance condition;  
monitoring circuitry for monitoring the outputs of the at least two oscillators, wherein the monitoring circuitry includes a control loop with a VCO and means for analog voltage monitoring of the VCO voltage to determine if the oscillators are operating;  
detection circuitry for detecting a failure or an out of tolerance condition of the oscillators; and  
switching circuitry for seamlessly switching from a failed or out of tolerance oscillator to an operating and in tolerance oscillator.
2. The redundant clock module of claim 1 wherein monitoring and detection circuitry is provided for each oscillator.
3. The redundant clock module of claim 1 wherein the oscillators are monitored by comparing the oscillator output frequency to the VCO frequency.
4. The redundant clock module of claim 1 wherein the monitoring circuitry includes analog voltage comparators to compare the control voltage of the VCO to a fixed reference voltage that is the equivalent of the frequency limit established by the tolerance desired and the VCO voltage versus frequency characteristic.
5. The redundant clock module of claim 1 wherein the detection circuitry generates

an error signal that indicates that an oscillator has failed or is out of tolerance.

6. The redundant clock module of claim 1 wherein the switching circuitry receives error signals from the detection circuitry for detecting a failed or out of tolerance oscillator.

7. The redundant clock module of claim 6 wherein the switching circuitry removes power from the failed oscillator and switches the output to a working oscillator.

8. The redundant clock module of claim 1 further comprising control circuitry with a control loop and a VCO having a slower response time than the detection circuitry control loop so that it does not change frequency quickly during switching from one oscillator to another.

9. The redundant clock module of claim 1 further comprising fault indication means for visually determining which oscillators has failed and needs to be replaced.

10. A redundant clock module comprising:  
at least two reference oscillators;  
at least two monitoring circuits for monitoring the outputs of at least two reference oscillators;  
a detection circuit for detecting a failure or out of tolerance condition of the oscillators;  
and

wherein the monitoring and detection circuits include analog voltage comparators to compare a control voltage of a VCO to a fixed reference voltage that is the equivalent of the frequency limit established by the tolerance desired and the VCO voltage versus frequency characteristic.

11. A redundant clock module comprising:

a reference oscillator input stage;

at least two frequency detect stages for monitoring outputs of at least two reference oscillators in the reference oscillator input stage, wherein the frequency detect stages include a phase-frequency detector, a control loop with a VCO, and a VCO control voltage for monitoring the outputs of the oscillators;

a frequency detect logic stage, wherein the frequency detect logic stage includes at least two analog voltage comparators to compare the control voltage of the VCO to a fixed reference voltage that is the equivalent of the frequency limit established by the tolerance desired and the VCO voltage versus frequency characteristic;

a power, startup, reset stage;

an oscillator select logic stage; and

an output control loop path stage, wherein the output control loop path stage includes a phase-frequency detector, a control loop with a VCO for allowing the output frequency of the VCO to change slowly in the event that a reference oscillator fails and outputting an reference oscillator output.